SB
193
C85

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 75.

B. T. GALLOWAY, *Chief of Bureau.*

SB193
.C85

RANGE MANAGEMENT IN THE STATE OF WASHINGTON.

BY

J. S. COTTON,

Assistant in Range Investigations,
In Cooperation with the Washington State Experiment Station.

GRASS AND FORAGE PLANT INVESTIGATIONS.

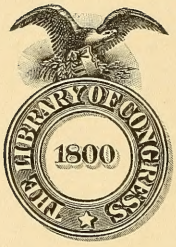
Issued May 23, 1905

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

Monograph

LIBRARY OF CONGRESS

SHOUT
SHARE
IT



Class SB193
Book .C85

1382

539
96

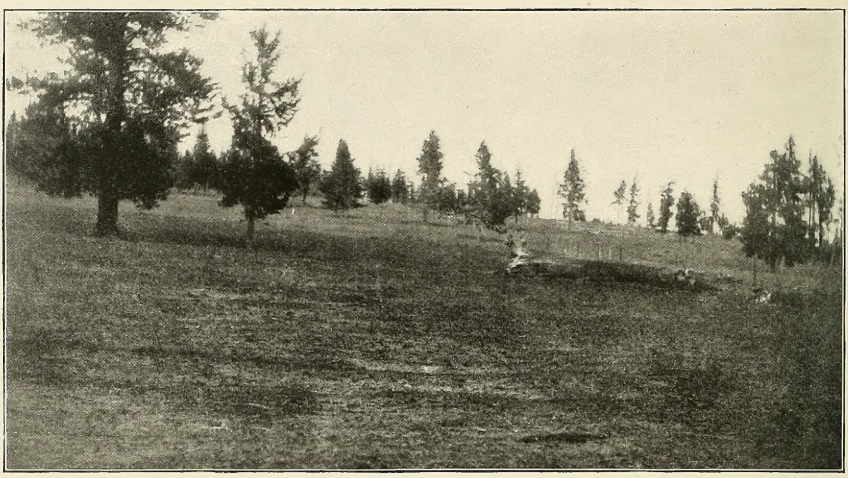


FIG. 1.—MOUNTAIN MEADOW WHERE TIMOTHY WAS SEEDED IN THE AUTUMN OF 1902.

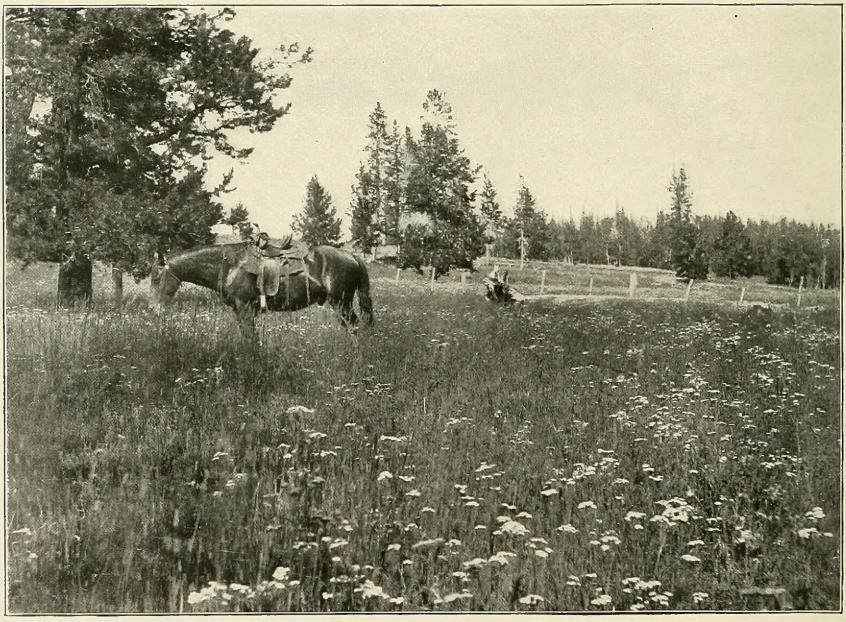


FIG. 2.—SAME PLOT SHOWN IN FIGURE 1, TWO YEARS LATER.

RANGE IMPROVEMENT BY RESEEDING.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 75.

B. T. GALLOWAY, *Chief of Bureau*

RANGE MANAGEMENT IN THE STATE OF WASHINGTON.

BY

J. S. COTTON,

ASSISTANT IN RANGE INVESTIGATIONS,
IN COOPERATION WITH THE WASHINGTON STATE
EXPERIMENT STATION.

GRASS AND FORAGE PLANT INVESTIGATIONS

ISSUED MAY 23, 1905.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

BUREAU OF PLANT INDUSTRY.

B. T. GALLOWAY,
Pathologist and Physiologist, and Chief of Bureau.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.
ALBERT F. WOODS, *Pathologist and Physiologist in Charge,*
Acting Chief of Bureau in Absence of Chief.

BOTANICAL INVESTIGATIONS AND EXPERIMENTS.
FREDERICK V. COVILLE, *Botanist in Charge.*

GRASS AND FORAGE PLANT INVESTIGATIONS.
W. J. SPILLMAN, *Agrostologist in Charge.*

POMOLOGICAL INVESTIGATIONS.
G. B. BRACKETT, *Pomologist in Charge.*

SEED AND PLANT INTRODUCTION AND DISTRIBUTION.
A. J. PIETERS, *Botanist in Charge.*

ARLINGTON EXPERIMENTAL FARM.
L. C. CORBETT, *Horticulturist in Charge.*

EXPERIMENTAL GARDENS AND GROUNDS.
E. M. BYRNES, *Superintendent.*

J. E. ROCKWELL, *Editor.*
JAMES E. JONES, *Chief Clerk.*

GRASS AND FORAGE PLANT INVESTIGATIONS.

SCIENTIFIC STAFF.

W. J. SPILLMAN, *Agrostologist.*

A. S. HITCHCOCK, *Assistant Agrostologist in Charge of Alfalfa and Clover Investigations.*
C. V. PIPER, *Systematic Agrostologist in Charge of Herbarium.*
DAVID GRIFFITHS, *Assistant Agrostologist in Charge of Range Investigations.*
C. R. BALL, *Assistant Agrostologist in Charge of Work on Arlington Farm.*
S. M. TRACY, *Special Agent in Charge of Gulf Coast Investigations.*
D. A. BRODIE, *Assistant Agrostologist in Charge of Cooperative Work.*
P. L. RICKER, *Assistant in Herbarium.*
J. M. WESTGATE, *Assistant in Sand-Binding Work.*
BYRON HUNTER, *Assistant in Charge of Pacific Coast Investigations.*
R. A. OAKLEY, *Assistant in Domestication of Wild Grasses.*
C. W. WARBURTON, *Assistant in Fodder Plant and Millet Investigations.*
M. A. CROSBY, *Assistant in Southern Forage Plant Investigations.*
J. S. COTTON, *Assistant in Range Investigations.*
LESLIE F. PAULL, *Assistant in Investigations at Arlington Farm.*
HAROLD T. NIELSEN, *Assistant in Alfalfa and Clover Investigations.*
AGNES CHASE, *Agrostological Artist.*

JAN 8 1907
D. of D.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., February 24, 1905.

Sir: I have the honor to transmit herewith the manuscript of a paper on Range Management in the State of Washington, which embodies a report upon investigations conducted in cooperation with the Washington State Experiment Station.

This paper is a valuable contribution to our knowledge of improvement of range lands, and I respectfully recommend that it be issued as Bulletin No. 75 of the Bureau series.

The accompanying illustrations are necessary to a complete understanding of the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

In the spring of 1901 cooperative arrangements were entered into between the United States Department of Agriculture and the Agricultural Experiment Station of the State of Washington for the conduct of investigations on range lands in that State. These investigations were inaugurated by the writer, who at that time was agriculturist of the Washington State Experiment Station, acting both for the station and for the Department of Agriculture, under the direction of the then Agrostologist, and the details of the work planned were carried out by Mr. J. S. Cotton, under the direction of the writer. This cooperative arrangement continued until the end of December, 1903. Since June 1, 1904, the work has been continued by the United States Department of Agriculture under the direction of the writer, the details of the work being again carried out by Mr. Cotton.

In 1901 experiments were undertaken on Rattlesnake Mountain, at a point 16 miles north of Prosser, Wash., with a view to determining what grasses could be established on the range by seeding by different methods. In October, 1902, similar experiments were inaugurated at the Wenatchee Mountain Station on the high range of mountains separating the Kittitas Valley from the Columbia Valley to the north.

In addition to the seeding experiments above mentioned, Mr. Cotton has spent much time in studying the methods used for managing stock upon the range throughout central Washington, and the accompanying bulletin gives the results of the seeding experiments and of Mr. Cotton's studies on range management. Some of the work has demonstrated that certain grasses can be established in favorable localities in a manner which is entirely practicable, while Mr. Cotton's conclusions regarding methods of range management can not fail to be of great interest to stockmen in that section.

W. J. Spillman,
Agrostologist.

Office of Grass and Forage Plant Investigations,
Washington, D. C., February 24, 1905.

CONTENTS.

	Page.
Introduction	11
Range improvements	13
Winter pastures	13
Semiarid lands	15
Mountain grazing areas	17
Protection of pastures	20
Alternation of pastures	23
Using pastures before ground is settled in the spring	24
Improvement of stock	24
Index of grasses and forage plants	25
Description of plates	28

ILLUSTRATIONS.

Page.

PLATE I. Range improvement by reseeding. Fig. 1.—Mountain meadow where timothy was seeded in the autumn of 1902. Fig. 2.—Same plot shown in figure 1 two years later, showing stand of timothy secured ..... Frontispiece.

II. Types of permanent range land not adapted to other uses. Fig. 1.—Typical scab land. Fig. 2.—A mountain meadow 28

III. Bunch wheat-grass pastures. Fig. 1.—Pasture that has been overgrazed until nothing but June grass is left. Fig. 2.—A bunch wheat-grass pasture that has been properly handled 28

22586—No. 75—05 M——2

B. P. I.—153. G. F. P. I.—110.

RANGE MANAGEMENT IN THE STATE OF WASHINGTON.

INTRODUCTION.

Owing to the greatly lowered carrying capacity of ranges in the State of Washington, investigations were begun in the spring of 1901 to determine, if possible, what steps must be taken to preserve these ranges and what methods should be used to bring the badly overgrazed areas back to their original state of productivity. These investigations were carried on cooperatively between the Bureau of Plant Industry of the United States Department of Agriculture and the Washington Agricultural Experiment Station from that time until January 1, 1904, when the experiment station withdrew. Since that time these investigations have been carried on independently by the Bureau of Plant Industry.

In the early nineties the ranges were very much overgrazed, and owing to the overcrowded conditions were deteriorating very rapidly. In 1896 the Northern Pacific Railway Company, in order to alleviate these conditions, which by that time had become very serious, instituted a system of leasing the railroad land, or odd sections, of the grazing areas to the stockmen. The motive in leasing this land was to prevent the destruction of the native forage plants of the grazing areas, which meant the removal of the stockmen from that region and a consequent loss of traffic to the railway company. The first lease of this kind was issued on July 1, 1896. Between that date and June 13, 1903, over 300 leases, embracing about 1,500,000 acres of land, were issued, and at the present time the greater part of these ranges is under the control of private individuals.

While this system was bitterly opposed by some of the stockmen, it really proved to be of great benefit to the State at large, as it enabled those people who had homes in the grazing country to secure control of the railroad lands about them by means of a lease, and thus protect themselves from the ravages of nomadic stock. The more progressive stockmen immediately availed themselves of this opportunity. The nomadic stockmen—to protect themselves from each other and to prevent being forced out of the country—also leased grazing lands sufficient for their needs. Had it not been for the large

numbers of range horses that were allowed to run at will throughout the entire year, and thus continue their depredations, this system would undoubtedly have proved very satisfactory.

Shortly after this leasing system had been inaugurated a heavy immigration to central Washington took place. This immigration, together with the discovery which had been made shortly before, that large areas of land previously supposed to be of value for grazing purposes only would grow wheat, caused a rapid settling up of this region. As a result, large areas of bunch-grass land were homesteaded and purchased, until at the present time nearly all the land that is smooth enough for cultivation is used in growing wheat, or is being prepared for that purpose. This rapid settling up of the bunch-grass land has forced the stockmen into the coulée and hill lands, too rough for cultivation, and into the true arid regions and the mountains. In the arid regions the range is also gradually growing less, a condition which will continue, as irrigation, owing to the incentive given it by Federal legislation, will be vastly extended in the near future.

The progressive stockmen, in order to keep pace with the rapid development of the country for farming purposes, which has resulted in the crowding of their stock into much smaller confines, have purchased railroad lands, and wherever possible they have also leased the State lands that are unfit for cultivation and have fenced them for grazing purposes. Many of the original purchasers of the range lands are now in a prosperous condition. Others, who have acquired their lands within the past two or three years, are finding themselves seriously handicapped owing to the badly depleted condition of these ranges. Although they have much more to contend with than those who purchased before the depletion of the ranges was so great they will with persistent effort and judicious management eventually be successful. Those who have been too slow to realize the changed conditions have found themselves without range land, and for the most part these men have been compelled to go out of stock raising as a business. At the present time there is very little free range land except in the high mountain areas, where the grazing season does not last more than five months, and in the Okanogan country.

In the Okanogan country, owing to the present laws, it is impossible to secure tracts of land larger than 160 acres. Upon so small an area no one can make a living, and settlers are therefore dependent in part upon the outside range. Fortunately for them the natural conditions have in the past protected the country from being made a wilderness by overgrazing. The winters are long and the snowfall is quite heavy, thus necessitating winter feeding. For this reason the range horses, which have been a very great factor in the destruction of the ranges to the south, are not found to any great extent in

this region. The strong opposition of the cattlemen, together with the long feeding season, has also prevented sheep from gaining an entrance to any appreciable extent. Again, the cattlemen themselves have been limited in the number of cattle they could run on a range by the quantity of hay for winter feeding they could raise on their irrigated ranches in the river and creek valleys. The Okanogan ranges will last for a number of years, but as the country is gradually settled up these grazing lands will eventually suffer the same fate as all other grazing lands in the State, unless some system can be devised for their protection.

The area of free range in the mountains is also rapidly decreasing. The creation of two large forest reserves in the Cascades—the Washington Forest Reserve in the northern part and the Mount Rainier Forest Reserve in the southern part—has greatly reduced the free mountain range. While, of course, stock is not entirely prohibited from these areas, the number allowed on them is far less than was accustomed to graze there before the reserves were created. This restriction has naturally resulted in a very crowded condition of the stock in the summer pastures outside of the reserves, and at the rate at which the grass was being taken a couple of years ago it looked as though these areas would soon be as badly devastated as the lower range lands. However, within the last three years the timber companies have been buying up large tracts, part of which they are leasing to cattlemen for five-year periods, while no stock is allowed on the remainder. At the same time, in the more accessible areas, where the grazing season is long enough to make it profitable to do so, the stockmen have been purchasing large tracts of this summer range. These purchases on the part of the timbermen and the stockmen living in the near vicinity have resulted in almost entirely shutting out nomadic stock from their summer range.

RANGE IMPROVEMENTS.

The purchasing of the range lands of the State is greatly simplifying the problem of range improvement. The instant that the stockman has fenced his land he is in a position to protect it from all outside interference, and can control the number of stock allowed on it. Instead of following the old system of grabbing all that he can before some one else gets it, he will try to use his grazing land so that it will yield him the highest results from year to year.

WINTER PASTURES.

In the true arid region, where sagebrush (*Artemisia tridentata*) is the prevailing vegetation, fencing and protecting the land from overgrazing during that season of the year when the native forage plants

are going to seed will in all probability be the only satisfactory method of restoration. This will not be at all difficult, for, owing to the scarcity of water and to the too great heat, the cattle and sheep are taken to the higher altitudes during the summer months. In this way the native vegetation will have a chance to make a good growth and go to seed each season without interference from the stock. Through this method the pasture will not only yield a crop of seed on which future improvements will be based, but the plants which have been grazed to a point very near that of extermination will be given a chance to regain their former vigor.

At the present time nearly all the perennial grasses have been destroyed. There are, however, enough of these remaining (having been protected by growing in clumps of sagebrush where stock could not reach them) to furnish a crop of seed, if given a chance, although this crop may be very light for the first year or two. In addition to these there are numerous annual grasses and weeds that make excellent feed which, if given an opportunity, will in time become quite abundant. There are also numerous perennial shrubs, such as white sage (*Eurotia lanata*), bitter brush (*Purshia tridentata*), hop sage (*Grayia spinosa*), and greasewood (*Sarcobatus vermiculatus*)—each having its characteristic locality—which yield a considerable amount of browse, and which will furnish seed for new plants.

The only time of year when special care will need to be exercised in the grazing of these pastures will be in the spring months, when the young plants begin to grow. If the land be too heavily grazed at that period the young plants will be entirely killed out. This trouble can, however, be easily remedied by dividing the grazing area into two or three pastures, and by grazing off that portion of the land which is to be allowed to restore itself during the winter and excluding the stock during the time the young plants are getting a start. The next year another field can be given a like chance, and so on, alternately. In this manner it would be only a few years—probably not more than seven or eight—before the so-called desert areas would be restored to their original carrying capacity before overgrazing took place. Meantime the stockman would have full use of his land, and would be able gradually to increase the number of stock grazing on it, provided he judiciously confined the aggregate of his stock to the limit of the carrying capacity of his range.

As an example of this, the writer has on several occasions observed with interest an area a few miles west of Sunnyside. In the early part of 1900 this land belonged to the open range. It was fenced during that season, and has since that time been used to some extent as a pasture. While this field has not been handled in an ideal manner, nevertheless the native perennial grasses, such as sand-grass or needle grass (*Stipa comata*), Indian millet (*Eriocoma cuspidata*), and

woolly wheat-grass (*Agropyron subvillosum*), have become considerably more abundant each season. By the season of 1904 these grasses had become so abundant that it seems fair to conclude that if given an opportunity they will in the course of another three or four years make a very good stand.

Another very strong proof of what can be done in the semiarid region is shown in that part of the open-range lands lying above the Washington Irrigation Company's canal, directly north of Prosser. Although fully as many sheep as ever graze on this land during the winter season, the range is actually improving. This is due to the fact that the range horses have become much less numerous, having been sold to settlers or shipped out of the State. In this way the vegetation has been given an opportunity to reseed itself, and it has also had a chance to make some growth during the summer while the sheep and cattle were in the mountains.

In the sandy, sagebrush area lying some 15 to 25 miles south of the Great Northern Railway, in Douglass County—commonly known as "the desert"—there are several thousand acres of range land where there is still excellent feed. This consists mainly of needle grass (*Stipa comata*), Indian millet (*Eriocoma cuspidata*), and sunflowers (*Balsamorrhiza careyana*), while bitter brush (*Purshia tridentata*) and various species of Eriogonum and Phlox furnish a large quantity of browse. The reason the vegetation in this area remains good while that about it has been very nearly destroyed is due to the great scarcity of water, which renders it almost inaccessible to stock during the hot weather. At the present time horses are the only kind of stock that can graze in this region during the summer months, and even they can only penetrate some 10 or 12 miles at the most, being compelled to go to water every day or two. By reason of this the vegetation has a chance to reach its full growth and to go to seed during the summer season. During the winter months, when stock can go for several days at a time without water, this vegetation is all eaten off, but this comes at a time of year when comparatively little damage is done.

SEMIARID LANDS.

The semiarid or true bunch-grass lands can also by judicious management on the part of the owners be brought back to their original state of productiveness. The best method for improving these areas will be to fence them and protect them from all nomadic stock, and give the native grasses a chance to restore themselves.

The two most important of the native grasses are bunch wheat-grass (*Agropyron spicatum*), which grows on the hillsides and plateau lands, and giant rye-grass (*Elymus condensatus*), which grows on the bottom lands and on the more or less alkaline situations.

At the present time there are large areas (see Pl. III, fig. 1) where all of the native grasses, except June grass (*Poa sandbergii*), have been destroyed. The latter—owing to the fact that it is not relished by stock after it begins to head out—is still quite abundant and furnishes a large amount of spring grazing. Wherever these plants are destroyed sagebrush (*Artemisia tridentata*) and rabbit brush or "yellow sagebrush" (*Chrysothamnus nauseosus*, *C. viscidiflorus*), and other weeds that are not relished by stock have taken their places.

There is considerable difference of opinion among the stockmen as to whether or not the native grasses, especially bunch-grass, will restore themselves if given an opportunity. Some claim that these grasses will come back if given a chance, while others maintain the contrary opinion. Both are in a measure correct. The truth of this matter depends largely upon how long these grasses have been too closely grazed. If they have been kept grazed down to a point where they have had no opportunity to go to seed for a number of years, and until the roots, unable to withstand the strain put upon them, have died out, they will, of course, not come back. If, on the other hand, as is for the most part true, the roots have not been absolutely killed out or there is still some seed left in the ground, these grasses will eventually restore themselves, although this process may be extremely slow.

During the seasons of 1901, 1902, and 1903 experiments were carried on in the Rattlesnake Mountains, where the annual precipitation is approximately 13 inches, to determine what grasses and forage plants would be of value for use in the restoration of the range. These experiments proved that bunch-grass could be successfully grown on cultivated ground. They also showed that alfalfa could be profitably raised in that locality and that hairy vetch (*Vicia villosa*) might prove of value in range improvement. In this work no forage plant was found that would give any better yield than the bunch wheat-grass or the other native grasses. Even if such a plant could be found it is doubtful whether it would stand the actual hardship that the bunch wheat-grass or giant rye-grass will endure, or would have the high feeding value of the two plants mentioned.

Where the range is in a very bad state of depletion, and where the native grasses have been nearly exterminated, it is believed that the process of restoration can be greatly hastened by gathering seed of bunch-grass and scattering it in those areas where it formerly grew. While experiments to prove this point have not been carried out, it is very probable that in favorable seasons reseeding would be very successful if the seed were harrowed in or, if more convenient, thoroughly stamped in by herding a bunch of sheep over the area seeded. Not only will reseeding hasten this process of restoration, but it will give the bunch wheat-grass a start over the weeds that are at the

present time taking its place in those areas where overgrazing is going on. Experiments to determine this point will be made during 1905. The same thing can be done with the giant rye-grass. At the present time the seed of these grasses can not be purchased, but usually it would not be difficult to gather it. This can be done by heading the grasses with a sickle and putting the heads in a sack, or, if a large quantity is desired, there is no reason why the bunch-grass could not be gathered with a header and thrashed out with a flail. A thrashing machine could be used instead of a flail if the wind were shut off. The giant rye-grass could easily be gathered by using a self-binder.

In the foothills region lying between the semiarid grazing lands and the mountain meadows there are large areas of scab land (land where the soil is very thin and gravelly and full of stones), especially on the hilltops (see Pl. II, fig. 1). In these regions the grasses have been almost completely destroyed, and the prevailing vegetation now consists of scab-land sagebrush (*Artemisia rigida*), mountain sagebrush (*A. arbuscula*), bitter brush (*Purshia tridentata*), and various species of Eriogonum, all of which furnish considerable browse. Under proper management the grasses here will eventually restore themselves, but the process will take a long time, in some instances probably ten to fifteen years. The restoration may be hastened by scattering bunch wheat-grass seed, but it is, perhaps, a question whether the process of restoration will not cost more than the original value of the land.

MOUNTAIN GRAZING AREAS.

The mountain grazing areas, or summer pastures, are at the present time very important factors in the range problem of the State. With the large quantities of hay that can be raised in the irrigated valleys for winter feeding, the number of range stock that the State can support is—except in the Okanogan country, where the quantity of hay raised is limited—directly dependent upon the number of stock that these summer pastures will carry.

Fortunately, the restoration of the mountain grazing areas will not be at all difficult. Here the annual precipitation is ample to support an abundant vegetation, which, if given an opportunity, will soon grow up again. While in many of the mountain areas the vegetation has been badly cleaned out by sheep, the most serious damage has been caused by stock tramping on the land too early in the season, which has resulted in the ground becoming badly packed. In the true mountain meadows (see Pl. II, fig. 2), where mountain clover (*Trifolium longipes*), mountain timothy (*Phleum alpinum*), and various sedges and rushes comprise the vegetation, there is still an abundance

of feed, but the carrying capacity of these places has been greatly reduced by the continual tramping of stock and consequent packing of the ground. On the hillsides surrounding these meadows, where the soil is much lighter, the herbage has in many places been killed. This, if protected and given an opportunity, will quickly return. The worst feature in this restoration process is that many weeds which have been brought in by the sheep, of absolutely no value for grazing purposes—not even the sheep will eat them—are given an equal chance with the good forage plants.

In many places, some of them covering large areas, the process of restoration can be very greatly hastened by reseeding. Not only can these areas be brought back to their original carrying capacity by reseeding, but it is the firm belief of the writer that in many instances their carrying capacity can actually be made much greater than ever (see Pl. I, figs. 1 and 2). This is especially true of the mountain meadows. In the majority of cases the reseeding can be done at a very small cost, varying from 75 cents to $2 per acre, depending on the kind of grass seed used and the number of pounds per acre. Even these figures can probably be lowered if the seed is bought in considerable quantity.

In the mountain meadows that are not too swampy, especially in those areas where mountain clover grows abundantly, timothy can be used to excellent advantage. For the outskirts of these meadows, where the soil is a little too dry for timothy to make its best growth, tall fescue (*Festuca elatior*), brome-grass (*Bromus inermis*), and probably orchard grass can be recommended. On the gravelly hillsides mountain brome-grass (*Bromus marginatus*), a native grass, can be grown to good advantage. So far as known, there is no seed of this latter grass on the market. However, if there should be sufficient demand for it, arrangements could be made for securing it.

The above conclusions have been reached after two years of experimentation and of study of the mountain conditions.

In the autumn of 1902 Messrs. W. H. Babcock and E. F. Benson offered the Office of Grass and Forage Plant Investigations the use of a section of land, which they agreed to fence, in their mountain pasture on the Wenatchee Mountains, about midway between Ellensburg and Wenatchee. This offer was gladly accepted, and experiments to determine what grasses could be used in the improvement of these mountain areas were immediately begun. The land selected is on top of the Wenatchee ridge, and is at an altitude of a little more than 5,000 feet. The conditions on this section are typical of true mountain range, varying from fertile mountain meadows and open parks to old timber burns and scab-land areas.

The following grasses and forage plants were seeded the same autumn: Timothy, Kentucky bluegrass (*Poa pratensis*), redtop,

white clover, and mountain brome-grass (*Bromus marginatus*). These were seeded in plots of approximately 5 acres each. On half of each of these plots the seed was broadcasted without further preparation. On the remaining half the seed was harrowed in with a spring-toothed harrow. In addition to these, small plots of Canadian rye-grass (*Elymus canadensis*) and wild wheat (*Elymus triticoides*) were seeded.

In the spring of 1903 the first five plots were duplicated and the following grasses and forage plants were added: Brome-grass (*Bromus inermis*), perennial rye-grass (*Lolium perenne*), Italian rye-grass (*Lolium italicum*), orchard grass, Canadian bluegrass (*Poa compressa*), tall fescue (*Festuca elatior*), sheep's fescue (*Festuca ovina*). hard fescue (*Festuca duriuscula*), cheat (*Bromus secalinus*), alsike clover, and red clover. All of these, excepting orchard grass, Italian rye-grass, sheep's fescue, and mountain brome-grass, were duplicated in the fall.

In the autumn of 1904 some of these grasses, together with six different kinds of vetches and some native grasses, were seeded on plowed ground. Reports of these 1904 experiments will be published when completed.

In the above experiments the following grasses have given totally negative results, the seed failing to germinate: Canadian rye-grass, wild wheat (*Elymus triticoides*), Kentucky bluegrass, white clover, and hard fescue (*Festuca duriuscula*). In the following cases the seed has germinated fairly well, but the plants have not made satisfactory growth: Canadian bluegrass, perennial rye-grass, Italian rye-grass, red clover, and alsike clover. It may be that another year the alsike clover will do better. So far the writer has been unable to determine whether the failure of this plant has been due to lack of nitrogen bacteria or to unfavorable conditions in the soil. Another year's work will probably demonstrate the cause of the failure of this plant.

Redtop and cheat (*Bromus secalinus*) have both made a fair growth, but can hardly be recommended at this altitude (5,000 feet). Of the entire list of grasses tested, the following, in the order in which they are named, have proved themselves adapted to mountain range conditions: Timothy (see Pl. I, figs. 1 and 2), mountain brome-grass (*Bromus marginatus*), tall fescue, and brome-grass. It is probable that orchard grass will also prove of value in such areas.

While these experiments have demonstrated that the range can be greatly improved by reseeding, they have also shown that, if it is possible to do so, the seed should be harrowed in. On those areas where the soil is loose, or where pine-grass (*Calamagrostis suksdorfii*) grows, a spring-toothed harrow will be found the most satisfactory. On those areas where the sedges and mountain clover abound, far

better results will be obtained, if the cost is not too great, by using a disk harrow. In many cases it is quite possible that a bunch of sheep would be fully as efficient, although this can not be recommended with assurance, as it has never been tried. The timothy seeded on the plots without harrowing, in the autumn of 1902, germinated fairly well, but the difference between the harrowed and unharrowed parts of the plot was very great—great enough, in fact, to well repay the cost of harrowing. The same thing held true on the plots of redtop and mountain brome-grass.

In the work of the spring of 1903 nearly all the seed not harrowed in failed to germinate, while wherever the seed was harrowed in a fair stand was obtained. This latter experiment, and a study of the soil conditions, would show it to be a waste of effort to seed in the spring without covering, as the top of the ground dries off before the seeds can get moisture enough to enable them to germinate and grow. Mr. Benson, one of the owners of the range, thinks that the experiments have shown conclusively that it is a waste of seed to sow it without harrowing. This is undoubtedly true of spring seeding, and probably also of fall seeding with many of the grasses. However, it is possible to sow timothy and mountain brome-grass and to secure a fair stand without covering, but, as stated above, the extra cost of harrowing will be well repaid.

The use of the harrow is also strongly urged for other reasons. It is very noticeable that wherever the harrow has been used the native grasses and forage plants have germinated much more profusely, and in small spots where there happened to be seed scattered from a few individual plants the stand has been greatly thickened. This is especially true of one of the forms of *Bromus marginatus*, which grows native on that section, of mountain needle grass (*Stipa occidentalis*), and of the wild pea (*Vicia americana*).

In this connection, fall seeding instead of spring seeding is recommended. The reason for this is that the snow usually comes early in the autumn and goes away late in the spring. As a consequence, the ground seldom freezes deep, and when the snow melts in the spring it has a tendency to bury the seed sown late in the fall. On the other hand, if the seed is sown in the spring the top of the ground becomes so dry within four or five days after the snow has disappeared that the seed will have no opportunity to germinate unless the season should prove to be an unusually rainy one.

PROTECTION OF PASTURES.

So far emphasis has been put on the fact that fencing is the main secret of range improvement. Yet fencing is absolutely of no value unless the stockman will treat his pasture with just as much care as he would his wheat field. Fencing is merely a means to an end.

Many of the stockmen, especially cattlemen, seem to think that when they have excluded the outside stock, sheep in particular, from their land, it will carry whatever stock they may have, and they are disappointed if it does not. While it is true that some kinds of stock do more damage to a given range than others, the injury is caused not so much by the kind as it is by the number of stock and the methods used in handling it. Just because the stockman has fenced his range and excluded all outside stock he must not lose sight of the fact that he has not in the least changed the carrying capacity of his range.

To illustrate this point, the writer, during the season of 1904, had an opportunity to study a number of pastures that had been newly fenced. One of these pastures, owned by a stock company, was purchased in the summer of 1903 and fenced during the spring of 1904. This pasture was in a region where there is a great deal of scab land, which meant that the carrying capacity was naturally very low, and in a locality where the vegetation had previously been nearly destroyed by numerous bands of sheep. The owners, having eliminated the sheep and all other stock, did not estimate its carrying capacity, but turned all of their cattle into the pasture without further attention. In the autumn, when they came to gather in their stock, they found that every bit of feed, including all the browse the cattle could get, was gone, and that the stock were in very poor shape, some of them being in a half-starved condition. These men by overgrazing their pasture lost heavily, as they will have to feed a great deal of hay to bring their cattle back to the condition they were in when turned into the pasture. Not only did they lose heavily on the cattle, but they also did the range a very serious injury, for, instead of supporting more stock another year, its carrying capacity has been greatly lessened.

Another range adjoining the one just mentioned has also suffered heavily from overstocking. In this case the owners, at the time they turned their cattle in, believed that their range would actually improve with what stock they had on it. However, they miscalculated, and not only will it take considerable hay to bring the majority of their stock back to good condition, but it will also be some time before the damage done to their range can be made good. While these two pastures were the only ones observed that were so overgrazed that the stock were really poorer when taken out than when put in, several other pastures were noticed in which the carrying capacity will be lower another year than it was during the past season, owing to the fact that the native vegetation has been too closely grazed.

The first step that the stockman should take after his pasture is fenced is to make a careful estimate of the number of stock it will

carry, *being very sure not to overestimate*, which he is almost certain to do. In making this estimate he must not base it on the maximum number of stock, i. e., all the stock that the pasture will carry and bring through in good condition without reference to the condition in which the pasture is left at the end of the season, but an optimum number. An optimum number of stock is that number which the pasture will carry and bring through in good condition at the end of the season, and still be left in condition to carry the same stock another year, and so on indefinitely. This means that the stockman must make a careful study of his range, and be ready to revise his estimates whenever he sees that it is necessary to do so. By far the safest plan will be to pasture somewhat under the optimum number, and thus be prepared for a mistake in the estimate or for an unusually dry year. In case the range is badly deteriorated when the stockman first gets control, it will be absolutely necessary that it be pastured considerably under the optimum number if he wishes his range to improve. While this may perhaps be a severe strain on him for the first year or two, it is nevertheless the only solution. In many instances he may be able to take advantage of the outside range while his pastures are improving.

Plate III, figures 1 and 2, shows very plainly the difference between maximum and optimum grazing. The pasture shown in figure 1 is very badly depleted and very little vegetation remains except June grass (*Poa sandbergii*) and weeds. This pasture, instead of being given a chance to revive, has been grazed to its highest carrying capacity each year, with the result that it is gradually deteriorating. The pasture shown in figure 2 belongs to the neighboring range. Its owner, instead of trying to get all out of his range that he possibly can from year to year, has, by using an optimum number of stock, given it a chance to improve. At the present time the carrying capacity of his range is at least double that of the pasture shown in figure 1.

Mr. Joseph Burtt Davy, in his report on the stock ranges in California, where the same range conditions have been passed through as are going on in Washington, says:

> Success on one range, as compared with failure on an adjoining one, is not due to any difference in location or other range conditions, nor to any difference in the grasses or other plants composing the pasture; the natural conditions generally are, or have been, identical with those of adjacent and less productive ranges. The secret lies in good management, and good management primarily consists in carrying the optimum number of stock and allowing plenty of grass to go to seed—to go to waste, as the majority of stockmen would call it.
>
> Mr. J. H. Clarke and Colonel Harding, both successful stock ranchers on a large scale, are agreed in declaring that over thirty years of experience proves that this surplus grass, instead of being wasted, is equivalent to so much capital invested in the range, and is the cause of the prosperity of the few as

compared with the failure or poverty of the many. Such men do not stock nearly up to the maximum. Owning their own ranges, and therefore not having to pay exorbitant interest on the capital invested, they are content with the profits obtainable from the optimum number of stock. As a result of this, they not only maintain a uniform carrying capacity without deterioration, but gain in other ways. Their wool is always cleaner and commands a half cent a pound more than that of their neighbors, and both their mutton sheep and their lambs command a higher price. "We aim," writes Mr. Clarke, "to keep no more stock than the range will easily support. Better a superabundance of feed than a scarcity." [a]

ALTERNATION OF PASTURES.

In many parts of the State of Washington the ranges would be greatly benefited if the owner instead of having one large pasture would subdivide it into a number of small ones, so that once in three or four years each pasture would have a chance to rest and reseed itself. This would not mean that the owner would be deprived of the feed from that field, but simply that he would let the field lie idle for a couple of months during the time of going to seed, and use the dry feed later in the season. It would probably be necessary to protect this field from heavy grazing long enough in the following spring to give the young plants a chance to become so well established that the stock would not pull them up.

This method has been tried with very good success in Texas, and has been found to be of great value in range restoration. Mr. J. G. Smith, formerly of the Office of Grass and Forage Plant Investigations of the Department of Agriculture, who made a careful investigation of the stock ranges of that State, makes the following statement:

> A rest of two or three months during the growing season in early spring would enable the early grasses to ripen and shed their seeds, thus perpetuating the early species. After the seed had fallen, the cattle could be turned on the grass for two or three months and again transferred to a fresh pasture. In the same way autumn and winter pastures can be secured. Several stockmen who have employed this method on a large scale for a number of years say that their ranges are continually improving, in marked contrast to the deterioration that had occurred through bad treatment of neighboring properties where the old methods were practiced. It is also claimed that pasture land thus treated will carry more head of cattle through the year and bring them out in better condition than where the herd has access at all seasons of the year to all portions of the range. [b]

Later experiments to prove this point were carried on by the Office of Grass and Forage Plant Investigations at Abilene, Tex., and the results have shown conclusively that alternation of pastures is one

[a] Bul. 12, Bureau of Plant Industry, U. S. Dept. of Agriculture, p. 43.

[b] Bul. 16, Division of Agrostology, U. S. Dept. of Agriculture, p. 22.

of the important steps in the improvement of the ranges of that State.[a]

In eastern Washington some of the more successful stockmen use this method to the extent of dividing their holdings into winter and summer pastures. Undoubtedly much of their success, as compared with the failure of others, can be very largely attributed to that fact.

USING PASTURES BEFORE GROUND IS SETTLED IN THE SPRING.

One of the most serious damages to the range is caused by turning the stock upon it too early in the season. A great deal of the injury that has been done by sheep is due to this cause. Their owners, in order to get ahead of others, have pushed the sheep out on to the bunch-grass land while the ground was still soft and "punchy." In this manner the ground became badly packed and many young plants were destroyed almost before they had begun to grow, while much of the prevailing vegetation was greatly retarded in its growth by being nipped too early in the season. This same process was kept up as they followed the retreating snow up into the high mountains. Numerous instances have been observed where sheep have been run over the mountain ranges even before the frost was out of the ground.

When the stockman once gets his range under his control he should endeavor to avoid too early grazing. He will find that in the long run it will be better to hold the stock from this area until the ground has become settled and the vegetation has had a good start. If it is impossible to do this, he should endeavor to confine the damage to as small an area as possible.

IMPROVEMENT OF STOCK.

Not only should the stockman do all he can to improve his land, but he should strive equally hard to improve the quality of his stock. In the early days, when there was plenty of good range, it made comparatively little difference about the quality of stock, as even a poor-grade animal would yield a good profit. To-day, with the rapid fencing of the range, these conditions are changed. Now grass almost everywhere costs money. Land must for the greater part be owned or rented. The stockman can no longer afford to keep that type of stock that does not give him the best returns for the effort expended and that will best cover his range, whether it be cattle, sheep, or horses.

[a] Bul. 13, Bureau of Plant Industry, U. S. Dept. of Agriculture, pp. 19 and 26.

INDEX OF GRASSES AND FORAGE PLANTS.

Agropyron spicatum (Bunch wheatgrass), 15, 16, 17.
subvillosum (Woolly wheatgrass), 15.
Agrostis alba (Redtop), 18, 19, 20.
Alfalfa (*Medicago sativa*), 16.
Alsike clover (*Trifolium hybridum*), 19.
Artemisia arbuscula (Mountain sagebrush), 17.
rigida (Scab-land sagebrush), 17.
tridentata (Sagebrush), 13, 15, 16.

Balsamorrhiza careyana (Sunflower), 15.
Bitter brush (*Purshia tridentata*), 14, 15, 17.
Brome-grass (*Bromus inermis*), 18, 19.
Bromus inermis (Brome-grass), 18, 19.
marginatus (Mountain brome-grass), 18, 19, 20.
secalinus (Cheat), 19.
Bunch-grass, 16, 17.
Bunch wheat-grass (*Agropyron spicatum*), 15, 16, 17.

Calamagrostis suksdorfii (Pine-grass), 19.
Canadian bluegrass (*Poa compressa*), 19.
rye-grass (*Elymus canadensis*), 19.
Carex spp. (Sedges), 17.
Cheat (*Bromus secalinus*), 19.
Chrysothamnus nauseosus and *C. viscidiflorus* (Rabbit brush or yellow sagebrush), 16.

Dactylis glomerata (Orchard grass), 18, 19.

Elymus canadensis (Canadian rye-grass), 19.
condensatus (Giant rye-grass), 15, 16, 17.
triticoides (Wild wheat), 19.
Eriocoma cuspidata (Indian millet), 14, 15.
Eriogonum, 15, 17.
Eurotia lanata (White sage), 14.
Festuca duriuscula (Hard fescue), 19.
elatior (Tall fescue), 18, 19.
ovina (Sheep's fescue), 19.

Giant rye-grass (*Elymus condensatus*), 15, 16, 17.
Grayia spinosa (Hop sage), 14.
Greasewood (*Sarcobatus vermiculatus*), 14.

Hairy vetch (*Vicia villosa*), 16.
Hard fescue (*Festuca duriuscula*), 19.
Hop sage (*Grayia spinosa*), 14.

Indian millet (*Eriocoma cuspidata*), 14, 15.
Italian rye-grass (*Lolium italicum*), 19.

Juncus spp. (Rushes), 17.
June grass (*Poa sandbergii*), 16, 22.

Kentucky bluegrass (*Poa pratensis*), 18, 19.

Lolium italicum (Italian rye-grass, 19.
perenne (Perennial rye-grass), 19.

Medicago sativa (Alfalfa), 16.
Mountain brome-grass (*Bromus marginatus*), 18, 19, 20.
clover (*Trifolium longipes*), 17, 19.
needle grass (*Stipa occidentalis*), 20.
sagebrush (*Artemisia arbuscula*), 17.
timothy (*Phleum alpinum*), 17.

Needle grass (*Stipa comata*), 14, 15.

Orchard grass (*Dactylis glomerata*), 18, 19.

Perennial rye-grass (*Lolium perenne*), 19.
Phlox 15.

Phleum alpinum (Mountain timothy), 17.
pratense (Timothy), 18, 19, 20.
Pine-grass (*Calamagrostis suksdorfii*), 19.
Poa compressa (Canadian bluegrass), 19.
pratensis (Kentucky bluegrass), 18, 19.
sandbergii (June grass), 16, 22.
Purshia tridentata (Bitter brush), 14, 15, 16.

Rabbit brush (*Chrysothamnus nauseosus* and *C. viscidiflorus*), 16.
Red clover (*Trifolium pratense*), 19.
Redtop (*Agrostis alba*), 18, 19, 20.
Rushes (*Juncus* spp.), 17.

Sagebrush (*Artemisia tridentata*), 13, 15, 16.
Sand-grass (*Stipa comata*), 14.
Sarcobatus vermiculatus (Greasewood), 14.
Scab-land sagebrush (*Artemisia rigida*), 17.
Sedges (*Carex* spp.), 17.
Sheep's fescue (*Festuca ovina*), 19.
Stipa comata (Needle grass or sand-grass), 14, 15.
Stipa occidentalis (Mountain needle grass), 20.
Sunflower (*Balsamorrhiza careyana*), 15.

Tall fescue (*Festuca elatior*), 18, 19.
Timothy (*Phleum pratense*), 18, 19, 20.
Trifolium hybridum (Alsike clover), 19.
longipes (Mountain clover), 17, 19.
pratense (Red clover), 19.
repens (White clover) 18, 19.

Vetches, 19.
Vicia americana (Wild pea), 20.
villosa (Hairy vetch), 16.

White clover (*Trifolium repens*), 18, 19.
sage (*Eurotia lanata*), 14.
Wild pea (*Vicia americana*), 20.
wheat (*Elymus triticoides*), 19.
Woolly wheat-grass (*Agropyron subvillosum*), 15.

Yellow sagebrush (*Chrysothamnus nauseosus* and *C. viscidiflorus*), 16.

PLATES.

DESCRIPTION OF PLATES.

PLATE I. *Frontispiece.* Range improvement by reseeding. Fig. 1.—Mountain meadow where timothy was seeded in the autumn of 1902. The prevailing vegetation in the foreground is mountain clover (*Trifolium longipes*), which makes very little growth. Fig. 2.—The same plot illustrated in figure 1 two years later, showing the stand of timothy secured.

PLATE II. Types of permanent range land not adapted to other uses. Fig. 1.—Typical scab land. Bunch wheat-grass grew abundantly in these areas before overgrazing took place. Fig. 2.—A mountain meadow. A typical place for seeding timothy. Tall fescue and brome-grass will grow to advantage along the timber edges.

PLATE III. Bunch wheat-grass pastures. Fig. 1.—Bunch wheat-grass pasture that has been continually overgrazed until nothing but June grass (*Poa sandbergii*) is left. Fig. 2.—A bunch wheat-grass pasture that has been properly handled. The photographs for figures 1 and 2 were taken on adjoining ranges.

O

FIG. 1.—TYPICAL SCAB LAND.

FIG. 2.—A MOUNTAIN MEADOW.

TYPES OF PERMANENT RANGE LAND NOT ADAPTED TO OTHER USES.

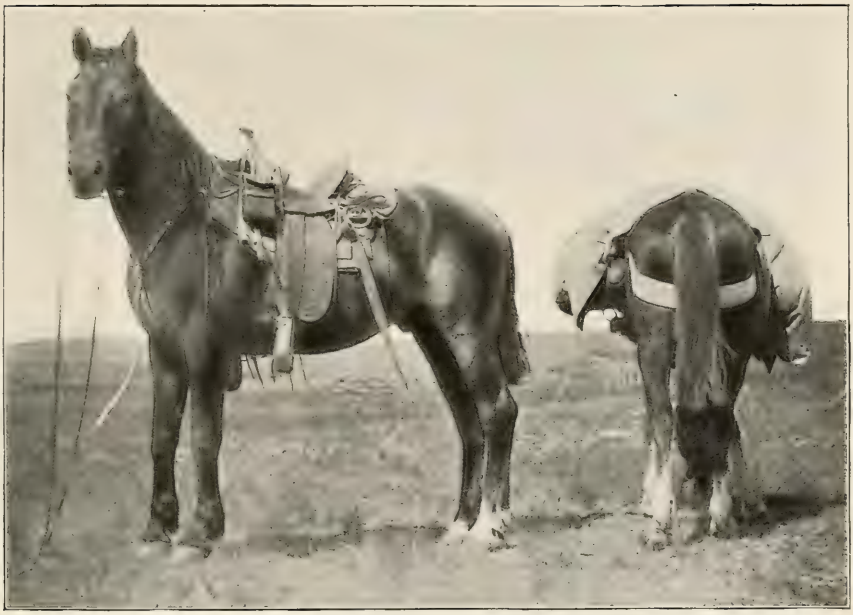


FIG. 1.—PASTURE THAT HAS BEEN OVERGRAZED UNTIL NOTHING BUT JUNE GRASS IS LEFT.

FIG. 2.—BUNCH WHEAT-GRASS PASTURE THAT HAS BEEN PROPERLY HANDLED.

BUNCH WHEAT-GRASS PASTURES.

E Mr '08

LIBRARY OF CONGRESS
00009300739